

Multiply Controlled Verbal Operants: An Analysis and Extension to the Picture Exchange Communication System

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This paper presents Skinner's (1957) analysis of verbal behavior as a framework for understanding language acquisition in children with autism. We describe Skinner's analysis of pure and impure verbal operants and illustrate how this analysis may be applied to the design of communication training programs. The picture exchange communication system (PECS) is a training program influenced by Skinner's framework. We describe the training sequence associated with PECS and illustrate how this sequence may establish multiply controlled verbal behavior in children with autism. We conclude with an examination of how Skinner's framework may apply to other communication modalities and training strategies.

Key words: augmentative communication, autism, verbal behavior, picture exchange communication system

According to Skinner (1957), it is more useful to understand the functional control over verbal behavior than to focus attention on its form. Skinner defined a number of fundamental verbal operants, such as mands, tacts, intraverbals, and autoclitics. Each of these was defined in terms of their consequences and relatively narrowly defined stimulus conditions. In addition, Skinner discussed "impure" verbal operants and those under multiple control, in terms of combinations of antecedents and consequences.

The development of certain communication training programs for children with a variety of severe disabilities, including autism, has been associated with Skinner's overall analysis (see, e.g., Guess, Sailor, & Baer, 1976;

Kent, 1974; Kozloff, 1974; Lovaas, 2003; Maurice, Green, & Luce, 1996; Romanczyk, Matey, & Lockshin, 1994; Sundberg & Partington, 1998). There are an increasing number of training programs that address teaching children verbal operants using modalities other than speech (see Reichle, York, & Sigafos, 1991; Schlosser, 2003). A more detailed analysis of the stimulus control associated with particular training procedures may elucidate problems associated with the development of spontaneous communication (see Carr, 1982; Moerk, 2000; Schreibman, 1988).

The picture exchange communication system (PECS) was developed as an alternative or augmentative system for young children with autism (Bondy & Frost, 1994b). The design of PECS and the sequence of initial training steps were influenced by Skinner's (1957) description of verbal operants and a behavior-analytic perspective regarding autism. A number of techniques have been designed within PECS that directly address how an un-

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TABLE 1

Elementary verbal operants and controlling variables

	Antecedent conditions	Behavior	Consequences	Example
Mand	Motivational operation (MO)	Verbal behavior (VB)	Specified by VB	Saying "soda" and receiving soda
Tact	Aspect of the current environment	VB	Educational (including social)	With soda in view, saying "soda" and hearing "that's right!"
Intraverbal	VB of another person	VB	Educational	Hearing someone say "1, 2, 3, 4 . . ." saying "5" and then hearing "that's right!"
Echoic	VB of another person	VB that is formally identical to other's VB	Educational	Hearing someone say "ball," saying "ball" and hearing "good talking!"
Autoclitic	VB of the speaker	VB	Affects the behavior of the listener relative to the speaker (educational)	"I <i>really</i> want a cookie" informs the listener about an aspect of the speaker

derstanding of multiply controlled verbal operants can assist in the rapid acquisition of complex verbal behavior in children who display marked deficits in their verbal repertoires.

Our purpose here is to expand upon Skinner's (1957) analysis of impure verbal operants (i.e., those that involve multiple control), especially insofar as it affects the design of communication training programs. After describing a set of impure verbal operants, we will look at the training sequence within the PECS protocol as an example of how this type of analysis can lead to more effective training sequences for children with autism and related verbal deficiencies. We also will review some recent concerns regarding potential limitations associated with the use of PECS.

VERBAL OPERANTS

Skinner (1957) defined several key verbal operants by delineating each operant's antecedent and consequence

controls (see Table 1; see also Peterson, 1978, for a description of the elementary verbal operants and their controlling relations). For example, a *mand* is a verbal operant "in which the response is reinforced by a characteristic consequence and is therefore under the functional control of relevant conditions of deprivation or aversive stimulation" (pp. 35–36). Michael (1988) sought to clarify the motivational conditions with a description of *establishing operations*, which have been further refined to the concept of *motivational operations* (Laraway, Snyckerski, Michael, & Poling, 2003). Skinner noted that the term *mand* has its roots in the words *command* and *demand*. Common examples of mands, especially for young children, include requesting specific items, requesting assistance, and rejecting offered items or activities (see Shafer, 1994).

A *tact* is evoked by "a particular object or event or property of an object or event" (Skinner, 1957, p. 82). Skin-

ner created this word from *contact* because this verbal operant is controlled by its contact with some aspect of the stimulating environment. Common examples of tacts include labeling or naming objects, events and activities, including the relations between items or events currently in the speaker's environment. Examples of general tacts include "I smell a rose," "It's a big ball!" "The dog is barking," and so forth.

The term *intraverbal* is used to define verbal behavior that is under the stimulus control of other verbal behavior, initially from other people but increasingly from oneself as one's verbal repertoire expands. Furthermore, the form of an intraverbal does not have direct point-to-point correspondence to the form of the preceding verbal stimulus. Common examples include answering questions such as "What's your name?" "How are you?" or responding to phrases such as "one, two, three, . . ." and "roses are red, violets are . . ." The *echoic* is a verbal operant that is also under the control of other verbal behavior, but its form matches (in part or whole) the form of the verbal stimulus. Common examples include verbal imitation of sounds ("moo," "ahhhh," etc.), words ("cookie," "doggie," etc.) or entire phrases ("I love you," "Thank you," etc.).

The *autoclitic* is the most complex and perhaps most difficult to understand of the verbal operants defined by Skinner (1957). Autoclitics are partly under control of the speaker's own verbal behavior (*auto-clitic* means *self-leaning*). They derive from the speaker's subtle impact on the listener, and essentially bring the listener in contact with aspects of what is controlling the speaker's verbal behavior. For example, a woman could say, "I want a cookie." However, if she said, "I *really* want a cookie" she is not informing someone about some aspect of the cookie; rather, she is telling more about herself, as speaker, or the conditions under which she is speaking. Skinner defined several different types of autoclitics including de-

scriptive, quantifying, and qualifying, each in accordance with the type of environmental control.

In addition to differences in stimulus control, an important distinction between mands as opposed to the other verbal operants (i.e., tacts, intraverbals, echoics, or autoclitics) involves the type of reinforcement for each operant. Whereas the mand specifies its own reinforcer, the other verbal operants are established and maintained by the verbal community via what Skinner (1957) repeatedly called "educational" reinforcement (see, e.g., pp. 56, 74, and 84). Examples of the educational reinforcers most often used by Skinner are what can be identified as social reinforcers (e.g., "right!" "thanks!" etc.).

Early behaviorally oriented communication training protocols often did not distinguish between classes of verbal operants (see, e.g., Lovaas, 1977). In fact, there were few attempts to define the target behaviors in terms of verbal operants (Tarleton & Bondy, 1991). Most early programs began by attempting to establish echoic behavior (i.e., "Say 'ball' ") and then intraverbal behavior, as in "What is this?" (but see our later discussion for an expanded analysis of such cases). A frequently noted limitation stemming from these programs, in addition to the very long periods of acquisition (Carr, 1982), was the lack of spontaneous speech generated by even successful children (Schreibman, 1988). However, by noting the stimulus control inherent in echoics and intraverbals, it is clear that such responses occur following the verbal behavior of other people and that we should not expect a great deal of generalization across operant classes in such tentative repertoires. On the other hand, mands and tacts are operants for which "spontaneous" has a clearer fit—requesting or commenting "out of the blue." Neither of these operants is under the stimulus control of immediately preceding verbal stimuli.

*Pure, Impure, and Multiply
Controlled Verbal Operants*

Skinner (1957) uses the term *pure* when describing a tact “determined solely by a specific feature of the stimulating environment” and maintained by “a completely generalized reinforcer” (p. 83). Thus, a “child who is taught to name objects, colors and so on when some generalized reinforcement (for example, the approval carried by the verbal stimulus *Right!*) is made contingent upon a response which bears an appropriate relation to a current stimulus” (p. 84) has engaged in a pure tact. An impure tact is described as “A common result [of] a mixture of controlling relations characteristic of both tact and mand” (p. 151). For example, Skinner notes that “When a housewife says *Dinner is ready*, not because of the generalized reinforcement characteristic of the tact, but mainly because her listeners will then come to the table, the response is functionally very close to the mand *Come to dinner!*” (p. 151). When, in addition to the stimulus being tacted, verbal stimuli are also part of the effective environment complex, then the ensuing verbal operant would be under multiple control, and thus could be, in part, similar to an intraverbal (or possibly more narrowly echoic or textual, etc.). By carefully noting all aspects of the effective stimulus complex for particular verbal operants, teaching arrangements can be designed more effectively.

For example, if a teacher were to hold up an apple and say, “What’s this?” the operant identified by the behavior of a child saying “apple” is a different one than if the child walked into the room and, on seeing an apple on a table, said “apple.” The latter would be a pure tact, assuming there are no additional controlling variables. Similarly, if the teacher said, “What is round and red and a fruit?” (without an apple present), and a child answered “apple,” the child’s answer would be characterized as a pure intraverbal.

Verbal responses controlled both by prior verbal stimuli *and* specific features or aspects of the environment would be better characterized as multiply controlled operants, in this case, a combination that we will identify as an *intraverbal-tact*. A variety of multiply controlled verbal operants that are sensitive to combinations of stimuli as well as combinations of controlling consequences are listed in Table 2.

Several examples may help to clarify each of the suggested complex operants. For instance, asking a child “What do you want?” when there is nothing of high value in sight could result in an *intraverbal-mand*, if the child were to answer with a specific request. In this case, the mand portion of the operant is identified because it is the receipt of the item specified by the answer that serves as the reinforcer as opposed to the educationally arranged (and often social) consequence provided by the listener. The teacher’s question provides the intraverbal aspect of the stimulus complex. The presence of the teacher’s question alters the child’s response from a pure mand to an impure mand. Reichle and Sigafoos (1991) noted that in training sequences in which children are taught to request in response to instructor questions, “the learner may learn to make requests only when instructed or otherwise prompted to do so” (p. 103). The unnoticed introduction of such stimuli into training protocols may result in learners being described as “prompt dependent” when, in fact, they have learned precisely what was taught. The lack of spontaneity frequently cited about children with autism (see Reichle & Sigafoos) includes the paucity of pure mands.

In similar fashion, if the specific item or event that a child mands is a part of the stimulating environment, such as the presence of a cookie or toy, then that verbal operant may be further specified by identifying it as a *mand-tact*, to distinguish it from both the pure mand and the pure tact. It also should be noted that the reinforcer for

TABLE 2

Complex verbal operants and controlling variables

	Antecedent conditions	Behavior	Consequences	Example
Mand-tact	MO plus a specific aspect of the current environment	VB	Specified by the VB and a specific aspect of the environment	With soda in view, saying "soda" and receiving soda
Intraverbal-mand	MO plus VB of another person	VB	Receipt of specified reinforcer plus educational	With MO and "What do you want?" saying "cookie"; getting cookie and a smile
Intraverbal-tact	VB of another person and an aspect of the current environment	VB	Educational	With a pencil in view hearing "What's this?"; saying "pencil"; hearing "that's right"
Intraverbal-mand-tact	MO plus VB of another person and an aspect of the current environment	VB	Receipt of specified reinforcer plus educational	With MO and a ball, hearing "I want . . ."; saying "ball"; getting the ball and "that's right!"
Echoic-tact	VB of another person plus specific object or aspect of current environment	VB that is formally identical to other's VB	Educational	With a ball present, hearing "ball"; saying "ball" and hearing "good talking!"
Intraverbal-echoic	VB (a mand for action) plus VB (as a model)	VB that is formally identical to the modeled portion of other's VB	Educational	Hearing "say 'ball' ," saying "ball" and hearing "good talking!"
Intraverbal-echoic-tact	VB of another person plus an aspect of the current environment	VB that is formally identical to other's VB	Educational	With a pencil in view, hearing "say 'pencil' "; saying "pencil" and hearing "good talking!"

a mand-tact is most likely that which is specified by the child's statement rather than the possibly accompanying social praise, especially for children with autism. If this form of mand were the only type of mand in which the child engaged, then the teacher must plan to remove (at least temporarily) the sight (or other controlling form of stimulation associated with the object or event) of the controlling stimulus before a pure mand could be acquired.

It is possible for vocal behavior that does not involve speech per se to func-

tion as a mand. For example, crying is initially elicited by properties of various circumstances but may quickly come under the control of particular consequences. These consequences may even influence the form of the crying, thus differentially shaping certain crying patterns to be associated with particular motivational operations. However, crying would not be considered a mand unless it is under the stimulus control of the "audience"—a term used by Skinner (1957) in his diagram concerning the mand (p. 38). That is,

if the form of crying is controlled solely by the motivational circumstances and not the presence of an audience (e.g., the listener), then verbal behavior has not been emitted. Furthermore, Skinner's refined definition of verbal behavior notes, "the 'listener' must be responding in ways which have been conditioned *precisely in order to reinforce the behavior of the speaker*" (p. 225). Ultimately, whether crying as a pure mand predates other mand-tacts is an empirical question that awaits further observation.

In a more complex case, if a child were asked, "What do you want?" while an apple and an orange were held before the child, the answer "apple" would be characterized as an *intraverbal-mand-tact*. The tact portion of the operant is identified by the controlling relation between the apple itself (as a specific feature of the environment) and the form of the answer. Here, too, early in the development of functional communication skills, it is unlikely that a child will come, without explicit training, to emit pure mands if such combined stimuli were used in the teaching procedure to establish the response.

A similar analysis may help us to understand imitation situations. In the pure echoic, the only prior verbal stimulus is exactly what is to be imitated. A teacher says, "ball" and a child responds, "ball." If the teacher adds another nonimitative stimulus to the complex, such as, "say 'ball,'" and the child responds, "ball," then that response is more accurately identified as an *intraverbal-echoic*. A pure echoic response would be identified if the child responded, "say ball" (as do many children with autism who display echolalic responding¹). In addition, if a

teacher held up a ball while saying "ball," the child's response of saying "ball" would best be characterized as an *echoic-tact* if the child would not respond "ball" without seeing it. Only if the child responded with saying "ball" solely in the presence of the ball, and thus without any prior verbal stimuli, would we designate a pure tact. In a similar manner, if the teacher said, "say 'ball'" while holding up a ball, the child's response "ball" would be identified as an *intraverbal-echoic-tact* until the individual stimulus elements that control the response could be established.

O'Neill (1990) suggests that "the differences between the mand, tact, and the intraverbal should be more clearly recognized in language training programs" (p. 59). It may be additionally helpful to identify examples of multiple control when attempting to teach verbal behavior to communication-impaired children. Such an analysis may seem cumbersome at first. However, it also may be beneficial to identify cases of multiple stimulus control when analyzing the failures of teaching methods and procedures. For example, if a child were taught to label a group of objects only when requested to do so, as in teaching the child to answer, "What's this?" with a variety of objects, then we should not expect the child to spontaneously label the same set of objects without explicit training. Spontaneous labels are functionally equivalent to pure tacts, whereas answers to questions regarding object names are a form of a compound operant, the intraverbal-tact.

CHILDREN WITH AUTISM AND COMMUNICATION TRAINING PROGRAMS

Children with autism are often described (especially when under 5 years of age) as displaying few social approaches to adults and as having impoverished repertoires for extending interactions initiated by others (Bondy & Frost, 1994a). For example, children

¹ As Skinner (1957) points out, not all examples of vocal imitation are echoic. If a child repeats sounds (including words, phrases, songs, or intonations) due to factors related to the self-reinforcement associated with such behavior, then no audience-mediated reinforcement is involved, and thus the response is not verbal behavior. In other words, not all vocal behavior is verbal behavior, a point, it seems, that not all communication trainers frequently acknowledge.

with autism often display limited eye contact or even gaze aversion, often preferring inanimate objects to interpersonal exchanges (Schreibman, 1988). One way of describing a host of social orientation deficits is by noting that these children seem relatively insensitive to social reinforcers. When these children first attend training programs, they often do not display functional verbal repertoires. For example, Bondy and Frost reported that 80% of preschool children with autism entering one statewide public school program over a 3-year period did not display functional communication skills. That is, the great majority of entering students did not use vocal or manual behavior, or augmentative systems, to control the receipt of significant reinforcers (including requests for preferred items, help, or a break), although several did engage in some vocal behavior.

Attempts to teach these children functional communication skills must address their current repertoires and deficits as well as the types of consequences that may be effective in educational arrangements. Essentially, these children tend not to be motivated by teachers' approval and praise (via displays of pleasure when the child accomplishes something). Thus, initial attempts to develop verbal operants such as tacts, intraverbals, or echoics by necessity must involve educational reinforcers that are not social in nature. The arrangement of such reinforcers has at times been quite contrived, as when using candy or other tangible rewards.²

The sequence of training from a number of behaviorally oriented language training programs often begins with nonverbal responses such as eye contact or compliance training (see,

e.g., Guess et al., 1976; Kent, 1974; Kozloff, 1974; Lovaas, 2003). Some of these steps have been identified as "prespeech attentive skills" (Romanczyk et al., 1994). The next steps usually involve developing echoic repertoires, frequently for vocal sounds as opposed to whole words. (This step may be preceded by attempts to increase the operant level of vocal sounds.) The training protocols often do not distinguish between labeling (i.e., tacts) and requesting (i.e., mands). In fact, it is often suggested that labeling should be established prior to requesting. In general, this sequential approach to language training has been justified, in part, by its apparent similarity to the language development sequence of typically developing children (i.e., babbling before vocal imitation before one-word utterances, etc.).

There are a number of reasons why this pseudo-developmental behavioral approach is inappropriate with children with autism. Although Skinner (1957) writes about mands prior to echoics, intraverbals, or tacts, he does not claim that mands are acquired before the other operants. Furthermore, there is growing experimental evidence to support Skinner's suggestion that these operants are acquired independently (see Oah & Dickenson, 1989; Twyman, 1996).

Moreover, for typically developing children, for whom socially based reinforcers are likely to be equally as motivating as various tangible rewards (in the absence of significant states of deprivation), there is no theoretical reason to suspect that one type of verbal operant should develop before another. Although the early attempts to systematically describe the initial language output of typical children were not behaviorally based or functionally defined (e.g., Brown, 1973; Nelson, 1973), a review of such records suggests that children are as likely to acquire "doggie" as a comment (non-imitative and reinforced by social reactions) as they are to acquire the word

² It should be noted that such contrived reinforcement relations have also been used to establish social forms of behavior, such as eye contact. Although a full analysis is beyond the scope of this paper, it is questionable whether eye contact reinforced by the receipt of snacks should be considered social.

as a request (nonimitative and reinforced by the receipt of an item or action). Furthermore, it is readily apparent that typically developing children acquire echoic repertoires because of playful (i.e., social) interactions with people, rather than because someone has arranged to give them a piece of candy upon the imitation of the word "candy." As noted earlier, one critical difference between preschool children with autism and typically developing children involves the types of reinforcers to which each is responsive.

USING SKINNER'S ANALYSIS TO ANALYZE LANGUAGE TRAINING SEQUENCES

A training protocol may clearly describe the actions of the teacher and thus allow us to make reasonable assumptions about the verbal operants being taught. For example, a common training sequence to teach spontaneous requesting may proceed as follows: (a) Establish eye contact under stimulus control of "Look at me"; (b) teach vocal imitation of individual sounds; (c) while showing a common object, the teacher says, "say 'ball'" and then praises imitation without giving the item to the child; (d) while showing an item, the teacher asks, "What's this?" and praises the child for naming the object; (e) the teacher points to various items in the room and praises the child for naming each item; (f) while showing an item, the teacher says, "What do you want? Say 'ball'" and gives the item to the child after appropriate imitation; (g) while showing an item, the teacher asks, "What do you want?" and gives the requested item to the child; (h) without saying anything (but with the item in view), the teacher gives the item to the child once it is requested; (i) the child walks over to the teacher and asks for something that is not in the immediate environment, and the teacher gets and then gives the item.

An analysis of the verbal operants taught in this manner would look like

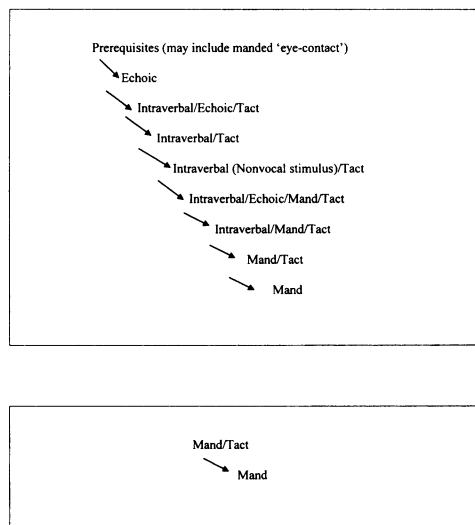


Figure 1. Top: training flowchart of skill sequence in some traditional language training programs to achieve the pure mand. Bottom: training sequence employed in PECS to establish the pure mand.

the flowchart in Figure 1 (top). By looking at the verbal operant sequence, we can plan for the types of teaching changes that would need to accompany each transition—whether we are adding a source of stimulus control, shifting it to another stimulus, or altering the source of reinforcement. We also can use this strategy to look at other sequences, such as that used in PECS to teach pure mands (Figure 1, bottom).

PECS TRAINING AND VERBAL OPERANTS

Although children with autism may not be highly motivated to obtain various socially based rewards, often they are interested in a variety of objects and events in their surroundings (Bondy & Frost, 1995). Children with autism may have favorite foods or toys, sometimes to the extent that they are called ritualistic or obsessive. It usually is relatively easy to identify a number of tangible items that a preschool child with autism is motivated to obtain. Given the power of particular tangible reinforcers and the relative paucity of

socially based reinforcers for a typical preschool child with autism who has just entered a school program, the mand is the first response taught in PECS. To teach eye contact or echoic responses (or even to follow an arbitrary type of matching-to-sample repertoire with objects, pictures, or other symbols) necessitates the use of tangible rewards for repertoires that should be associated with the types of educational reinforcement that Skinner (1957) noted. Therefore, in PECS training, the first response involves reinforcers that are currently effective and does not involve the prior verbal behavior of someone else. Thus, the mand is the first response taught in PECS.

Training on PECS begins with a reinforcer assessment (Frost & Bondy, 2002). Once the teacher has identified potential rewards (i.e., those items that the child persistently reaches for), the child is physically assisted (from behind by one trainer) to give someone (who controls access to the desired item) a picture of that item. Upon receipt of the picture, the teacher says, "Oh, cookie!" (or something similar) and immediately gives the child the reward. Because there is no vocal prompting prior to the exchange, the response is not under the additional stimulus controls associated with the intraverbal. Although the receiving teacher may use an open hand during this early stage of training (after the child initiates an action toward the reward or the picture), this action acts to enhance the audience effect of the listener for all forms of verbal behavior (see Skinner, 1957, pp. 173 and 176) rather than for a specific mand. The trainer delays the open hand cue until the child reaches for the reward or the picture to avoid the open hand functioning as a controlling stimulus for the picture exchange. An echoic repertoire is not being established, because the exchange is physically prompted and no modeling is used. However, during this initial phase of training, the object sought by the child is part of the stim-

ulating environment, and thus the function of the response may best be described as the compound mand-tact. To produce a pure mand, the objects mandated must be removed from the stimulating environment.

It should be noted that the initial reach for the reinforcer by the child is not viewed as a communicative act; that is, it is not verbal behavior. The reach is controlled by the reinforcer and not by the social context. The child is as likely to pick up candy from a tabletop as from a hand. The aim of Phase I is to shape the nonverbal reach into verbal behavior directed to the listener.

The physical prompts to pick up, extend, and exchange the picture are faded using a backward-chaining format. Thus, the last response usually taught (i.e., the physical prompt that is faded last) involves picking up the picture. Within a few trials of independently exchanging pictures for objects while the listener is within arms' reach, the listener begins to move farther from the child to teach the child to seek out the listener wherever he or she may be in the environment. In addition, very early in training, other teachers take on the role of listener so that the exchange does not depend solely on one person. A final aspect of this early phase of training is teaching the child to move to the picture and then find the listener. This contingency enhances searching for the picture even if the picture is neither near the desired object nor near the listener. At the successful completion of this aspect of training, the child can find a single picture, pick it up, take it to someone who controls access to a desired object, and hand the picture to that person. The child initiates the interaction, which is very often the first formal social interaction initiated by the autistic preschooler.

O'Neill (1990) has suggested that "Learners may need to be trained to mand for a listener's attention prior to manding for particular items or other outcomes" (p. 120). PECS does not require such prerequisite training be-

cause giving the picture to the teacher functions in a similar manner to the mand for attention noted by O'Neill. However, during the initial exchanges between child and adult, most children are looking at the hand of the teacher when they approach with their picture rather than at the teacher's eyes. To establish the importance of eye contact as a critical feature of the listener, the teacher is advised to sit with his or her head (and thus eyes) cast downward as the child approaches with a picture. A second teacher physically guides the child to touch the teacher's shoulders or gently lift the teacher's face prior to extending the picture. This step can be added only after the exchange is established. This training sequence essentially teaches the child that the eye contact of the listener is important to set the occasion for the exchange. Thus, rather than the traditional approach of teaching the child that it is important for the child to look at the teacher's eyes, in the PECS framework a child is taught that it is important to make the teacher look at the child.

During these early trials, the teacher places only single pictures in each situation during which particular reinforcers are most likely to be effective. The next phase introduces discrimination between pictures. A variety of techniques may be used to develop discrimination, but one strategy is to use pairs of pictures in which one picture is of a stimulus particularly relevant to immediate contextual cues and rewards and the other picture is of a stimulus that does not fit the immediate context. For example, assume that a boy has learned to mand a spoon when a bowl of cereal is visible on the kitchen table. Furthermore, the child has learned to mand turning on the television while in the living room. In a situation in which the strength of manding for the television is very high, if he selects the spoon picture when presented together with the television picture, he is given the spoon (rather than being told he is wrong or has made a mistake). If the boy does not seem to care about the

outcome (i.e., he seems as content with the spoon as with having the television turned on), then he is unlikely to attend to the visual stimuli or to make an appropriate discrimination between the pictures. However, children who react with surprise or annoyance with receipt of the spoon often follow with correct discriminations of the pictures. For these children, specialized error-correction procedures are helpful in facilitating discriminations between contextually relevant and irrelevant pictures (see Frost & Bondy, 2002).

We also create situations in which children are tested for their correspondence between the item requested and the item selected. That is, given equally reinforcing choices, we cannot anticipate which item the child wants on a particular trial. Thus, the second part of discrimination training involves saying, "go ahead," "take it," "show me," and so on. (Naming the item is avoided at this point to circumvent potentially having the children respond as if instructed to take that item rather than assessing what the child wants.) When children reach for the item requested, they are allowed immediate access. If children select an item that does not correspond with the picture selected, then an error-correction strategy is used. Correct performance is maintained as the number of pairs of items and corresponding icons varies across the day and as the array expands; thus, conditional discrimination is fully observed.

After a child has learned to mand accurately when given pairs or even an array of pictures, it is important to teach the child to tact. However, when a child can use only a singly presented picture, it may be difficult for the communicative partner to discern the function of the child's picture exchange. Is it a mand or a tact? At a comparable point in speech development, when typically developing children emit single-word utterances, they can mand as well as tact. We can sometimes discriminate which verbal operant was spoken by hearing differences in the

child's inflections (or intonation patterns) that accompany these single words. Intonation functions as an autoclitic (Skinner, 1957, pp. 315 and 355), so it is important to develop an autoclitic equivalent to intonation at this phase of PECS training for children to be able to clarify the function of their picture exchange.

One type of autoclitic developed in PECS is designed to function as an "autoclitic frame" (Skinner, 1957, p. 336). The frame is added to the single picture previously established without changing the nature of the overall function. The child is taught to construct the sentence "I want cookie" with two distinct pictures. The "I want" frame is a single picture. The use of the frame is taught in a backward-chaining format, with the frame initially being placed on a removable card, called the "sentence strip," by the teacher (see Frost & Bondy, 2002, for more procedural details).

The next phase of training aims to bring the child's request under the influence of spoken words by someone else; that is, we introduce an intraverbal-mand. This step is accomplished by asking, "What do you want?" while simultaneously pointing to the "I want" card, and then introducing a progressive delayed-prompt strategy to remove the gestural prompt. The form of the response—using the sentence strip to create "I want cookie"—already is available in the child's repertoire; however, the use of the question by the teacher brings the response partially under the control of the verbal stimulus introduced by the teacher. At this point in training, the child can mand or respond to a question with an intraverbal-mand. This compound function leads to the next phase.

During the next phase of training, the teacher introduces new autoclitic frames to the communication board. These frames include "I see," "I have," "I hear," and so on. With a minimally desired object in sight, the teacher asks, "What do you see?" while simultaneously touching the "I

see" card. This gestural prompt, established in the previous phase of training, is likely to be sufficiently effective so that the child picks up the card and places it on the sentence strip. The child is then likely to place the corresponding picture on the sentence strip and give it to the teacher. Upon its receipt, the teacher reads back, "I see the ball!" or something similar but does not give the ball to the child. The response being established is an intraverbal-tact controlled by both the preceding verbal stimulus and a particular aspect of the environment resulting in educational consequences but not that specified by the response itself. Were the teacher to provide the ball, the child may simply be learning another form of a mand.

To develop pure tacts, the verbal aspect of the stimulus complex preceding an intraverbal-tact must be faded. A variety of procedures may be used. Some strategies involve introducing a specific mand "What do you see?" or a general mand, such as "Look!" or "Wow!" while displaying an item to tact. Subsequent trials would then fade the specific or general mand and retain the item. Over time these vocal prompts could be faded and replaced by nonvocal prompts such as an arched eyebrow or an expectant look by the teacher. To the extent that tacts are emitted solely in association with even general mands, whether vocal or nonvocal, it must be recognized that a pure tact has not been established.

PECS AND OTHER VERBAL BEHAVIOR SYSTEMS

There are a number of communication modalities available to children with autism in addition to PECS (see Ronski & Sevcik, 1997, and Mirenda, 2002, for reviews). Among them, picture-pointing and sign-language systems are used widely. Each system is subject to the same considerations from Skinner's (1957) analysis as PECS. As discussed in the previous section, PECS differs from some lan-

guage training programs in that it seeks to establish spontaneous communication by removing prior verbal behavior as a source of control. The resulting verbal operant, the mand-tact, may be more likely to be emitted spontaneously without the prior verbal stimuli of an attending listener (e.g., "What do you want?"). To establish purer mands, the presence of the reinforcing object is later removed from view, so that the only source of control is a motivational operation and the presence of a listener. Although a similar training sequence may be applied to pointing and sign-language systems, certain conditions make the establishment of pure mands more difficult.

Picture-pointing systems require the speaker to select a picture symbol from an array and point to it. The difficulty here is that the pointing response is not necessarily taught under the control of a listener. Rather, a simple matching-to-sample format is often used in which the trainer shows an object and prompts the speaker to point to a corresponding picture of the object followed by some arbitrary consequence (e.g., Berkowitz, 1990). Matching to sample is not a prerequisite to becoming a speaker. Rather, the speaker must learn to gain a listener's attention, and should receive specific reinforcement (i.e., the item to which the student has pointed) from the listener. When picture pointing is taught in the traditional manner, spontaneous mands may be less likely to occur for children who are relatively insensitive to socially mediated reinforcement, such as most young children with autism.

In contrast to picture-pointing systems and PECS, users of sign language traditionally are taught with modeling prompts (Bonvillian & Blackburn, 1991). The acquisition of a meaningful sign-language vocabulary depends on the speaker successfully imitating the trainer's signs. Therefore, when a mand is initially taught with sign language, the sources of control are not only a motivational operation and the reinforcer itself, but also the trainer's

prompt. The resulting impure operant is more accurately described as a *mand-tact-duplic*. Refining Skinner's (1957) category of the echoic, Michael (1982) defines the duplic as a verbal operant in which "(1) . . . the response form is controlled by a verbal stimulus, and (2) the response product has formal similarity with the controlling stimulus" (p. 3). In the current example, the controlling stimulus is the trainer's prompt, and the response product, the speaker's sign, has formal similarity with the prompt. The trainer's prompt is a prior verbal stimulus that must be faded from the teaching situation before mand-tacts or pure mands can occur. Some users may acquire mand-tacts or pure mands more quickly with PECS because duplic control is not present in the initial phases of training (Tincani, 2004). Therefore, avoiding modeling prompts may minimize prompt dependency when teaching sign language, particularly for speakers who have difficulty imitating trainer signs.

The terms *selection-based* and *topography-based* verbal behavior have been suggested to account for differences in acquisition between picture-based and sign-language systems (Michael, 1985; Potter & Brown, 1997; Shafer, 1993; Sundberg, 1993; Sundberg & Partington, 1998). In selection-based systems, all responses are topographically similar and involve the selection of an appropriate stimulus from an array. PECS and picture-pointing systems are selection based. In topography-based systems, the topography of response varies between responses and does not involve the selection of a stimulus. Sign language is a topography-based system because each sign has a different form (e.g., the sign for ball is different than the one for dog), and the speaker does not select a stimulus from an array. It has been proposed that selection-based systems like PECS may be more difficult to acquire because of disadvantages purported to be intrinsic to selection-based verbal behavior.

One purported disadvantage of selection-based systems relates to conditional discrimination (Catania, 1998). A motivational operation (e.g., food deprivation) or conditional stimulus (e.g., presence of a favorite toy) increases the evocative strength of a picture symbol, which the speaker must scan, select, and exchange with a listener. Michael (1985) and others (e.g., Sundberg & Partington, 1998) argue that the scanning repertoire necessary to use selection-based systems may be absent in young children with autism or persons with mental retardation. Acquisition of PECS may therefore be delayed for children who do not have prior scanning or conditional discrimination skills. Although PECS does require the speaker to make conditional discriminations when selecting from an array of pictures, picture scanning and conditional discriminations are not prerequisite skills for learning PECS. There are at least two reasons why these skills have not inhibited most users from acquiring the PECS system. First, the previous section describes explicit procedures for establishing discriminated picture selection in PECS. In our experience (Bondy & Frost, 1994a), the large majority of children taught in this manner can acquire picture symbol discrimination. Moreover, there are numerous examples in the research literature of persons with developmental disabilities who acquire conditional discrimination through specialized teaching procedures (see Williams & Reinbold, 1999). Second, conditional discrimination as taught in the traditional matching-to-sample format with arbitrary reinforcement is fundamentally different than picture symbol discrimination as taught in PECS. Children who do not acquire conditional discrimination in the traditional manner may fail for a variety of reasons unrelated to PECS, including the absence of strong motivational operations, the use of weak secondary reinforcers, and failure to remove or transfer prior sources of stimulus control.

In addition to concerns about con-

ditional discrimination, Sundberg and Partington (1998) suggest that, in contrast to sign language, there is no verbal community that uses pictures to communicate. On the other hand, almost anyone can understand picture symbols (Berkowitz & Buyrberry, 1989), which do not require a specialized repertoire for either the child or the listener.

Selection of a communication system for children with autism should be directed by an analysis of the relevant contextual variables. The training sequence employed by PECS seeks to establish spontaneous verbal behavior in children with autism by carefully examining the sources of control for pure and impure verbal operants. Strategies that are commonly used to teach children verbal behavior with picture-pointing and sign-language systems may fail to address these critical sources of control. As a result, children with autism may experience delayed acquisition of verbal behavior, or they may emit verbal behavior only under certain fixed stimulus conditions (e.g., in the presence of trainer prompts). The notion of selection- and topography-based verbal behavior seems to represent a departure from Skinner's (1957) analysis because it shifts attention from the function of verbal behavior back to its form. When viewed from a functional perspective, differentiating between selection- and topography-based verbal behavior adds little to our understanding of how children with autism may learn to communicate.

SUMMARY

The development of effective communication training programs has, in part, been associated with Skinner's (1957) functional analysis of verbal behavior. Strategies that address issues related to stimulus control and sources of reinforcement have yielded effective training protocols. It is suggested here that the difficulties in establishing some types of verbal behavior, especially with populations that display

weak responding to socially based reinforcers, may be reduced by a more detailed analysis of verbal operants for which there may be multiple sources of stimulus control. A variety of complex verbal operants has been described with the intention of stimulating discussions regarding procedures to improve the manipulation of stimulus control across communication training procedures.

The analysis suggested was applied to PECS. A similar analysis may be beneficial when reviewing other communication training programs, whatever their stated theoretical underpinnings or their target modality. That is, a behavior analysis may describe how stimulus control and control by consequences is arranged over time within the recommended training steps. For example, someone may claim to teach "receptive labeling." Regardless of the term used, the teaching protocol can be analyzed to establish which stimuli (from environmental, verbal, and social sources) and which types of consequences actually determine specific behaviors. The description of the three-term contingency defines the operant, rather than the intentions or philosophy of the trainer. This emphasis on observing actual teacher-learner interactions applies equally to trainers who claim to teach specific verbal operants. In the top panel of Figure 1 we outline a sequence of training steps that can be observed in many language training programs that seek to teach manding (or spontaneous requesting), as well as the sequence of training steps to achieve the same outcome using the protocols suggested in PECS. As we suggest, some training programs stop short of achieving pure manding, as when they end the training sequence once a child can request from a number of items visible on a tabletop. Other programs stop their training protocols once a child can respond to "What do you want?" We hope that our analysis will help to review and compare different training protocols independent of their modality.

It may well be that specialists with nonbehavioral backgrounds have developed effective communication training strategies. Their use of terms unfamiliar to us should not deter us from an analysis of the operants actually taught by the described protocols. Such an analysis may broaden our own teaching strategies and lend a common language base to the comparison of otherwise disparate orientations. Rather than offering specific strategies to teach specific skills, the most important contribution of Skinner's *Verbal Behavior* (1957) is its potential use as an analytic tool.

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